AUSTRALIAN FOSSIL CRINOIDS.

II. Tribrachiocrinus clarkei McCoy.

By G. M. Philip, Geology Department, University of New England.

(Plate iii; one Text-figure.)

[Read 24th June, 1964.]

Synopsis.

The holotype of the Permian crinoid *Tribrachiocrinus clarkei* McCoy, type species of *Tribrachiocrinus* McCoy 1847, is re-described and figured. The morphology and affinities of *Tribrachiocrinus* are discussed and it is concluded that the genus is best included in the inadunate crinoid family Sundacrinidae Moore and Laudon 1943.

The first Australian fossil crinoid to be named was *Tribrachiocrinus clarkei* McCoy, type species of *Tribrachiocrinus* McCoy 1847. Subsequently four other species of *Tribrachiocrinus* have been diagnosed from the Permian of eastern Australia. However, no little confusion exists as to the nature of the genus.

Although McCoy originally gave what prove to be reasonably accurate figures of the type species, different interpretations were subsequently given by de Koninck (1877), Wachsmuth and Springer (1886), Bather (1890, 1900) and Etheridge (1892). Wachsmuth and Springer inferred that seven rami arose from the calyx, whereas Bather depicted three of the radials as compound. Perhaps because of this confusion Wright (1936) included a Scottish Carboniferous species in *Tribrachiocrinus*, although later (1952) he proposed a new genus for this form.

Not only have details of the morphology of *Tribrachiocrinus* long remained obscure, but also doubts have been raised recently as to the broader affinities of the genus. *Tribrachiocrinus* was regarded as a dicyclic inadunate crinoid by the authorities of the last century. Strimple (1951, p. 200), however, has observed that "In the study of an entirely different problem, Dr. R. C. Moore and the author concluded that *Tribrachiocrinus* probably belongs to the Flexibilia rather than the Inadunata". Wright (1952, p. 138) comments that "There is justification for this view . . . chiefly on account of the tripartite IB circlet and possibly also on the character of the R facets".

In order to establish the nature of *Tribrachiocrinus* it was necessary to study the holotype of *T. clarkei.* The specimen was included in the material sent to Adam Sedgwick by W. B. Clarke in 1844, and is now lodged in the Sedgwick Museum, Cambridge, where it is catalogued as E10564. Opportunity to study the specimen was found during the tenure of a Commonwealth Scientific and Industrial Research Organization Overseas Studentship at the Sedgwick Museum. I am most obliged to Mr. A. G. Brighton, Curator of the Sedgwick Museum, for his assistance. An account of other species of *Tribrachiocrinus* will be given at a later date.

Tribrachiocrinus clarkei McCoy. (Text-figure 1; Pl. iii.)

Tribrachyocrinus Clarkii McCoy, 1847, *Ann. Mag. nat. Hist.* 20, p. 288, Pl. 12, fig. 2; McCoy, 1851, *Proc. roy Soc. V.D. Land* 1, p. 315, Pl. 12, fig. 2.

Tribrachyocrinus Clarkei McCoy, de Koninck, 1877, *Mém. Soc. Sci. Liège* 6, p. 161, Pl. 6, figs 5, 5*a-d.*

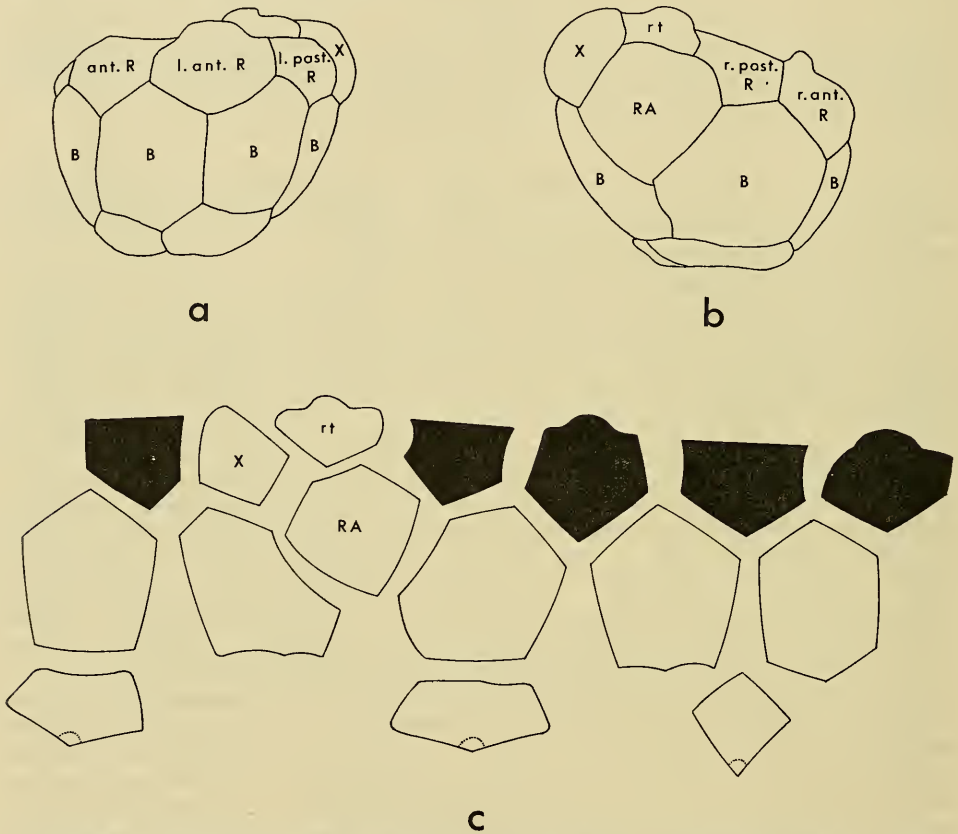
Tribrachiocrinus Clarkei McCoy, Wachsmuth and Springer, Revision of the Palaeocrinoidea III, p. 175; Etheridge, 1892, *Pal. Mem. geol. Surv. N.S.W.* 5 (2), p. 90, Pl. 13, figs 2–4, Pl. 14, fig. 3, Pl. 17, figs 2–4.

Description: Holotype large, hemispherical and somewhat flattened so that X and rt (= right proximal tube plate) have slipped over the l. post. R, and the RA under the

post. B. Plates thick (post. B *c.* 3 mm. thick) and sutures deeply incised. Surface generally smooth (? worn), but RA and post. B are dimpled with the ridges between the depressions arrayed roughly at right angles to the sutures. Stem cicatrix sunken and small, with portion of a rounded columnal 3 mm. in diameter adhering to the calyx.

IB circlet tripartite with IBB extending well up the side of the calyx. Lateral IBB approximately twice the size of the ant. IB, apparently consisting respectively of fused r. ant. and r. post. IBB, and l. ant. and l. post. IBB.

BB large and generally irregularly hexagonal, except the post. which is heptagonal and the l. post. which is pentagonal.



Text-fig. 1. *Tribrachiocrinus clarkei* McCoy. (*a*) Anterior, (*b*) Posterior views of holotype, (*c*) Plating analysis of holotype. × 4/5.

RR smaller and incurved, so that the dorsal margin of the cup is constricted; r. and l. post. and ant. RR possessing wide and shallow brachial facets with elongate dorsal ligament pits and obscure fulcral ridges. Brachial facets lacking on r. and l. ant. RR, which, together with rt, possess rounded protuberant rims which rise above the level of the cup as defined by the other RR.

Three anal plates present within the cup, comprising a large pentagonal RA surmounted to the left by a pentagonal X and to the right by a small quadrangular rt. Whether or not anal X contributes in the rim of the cup, or rt. and the l. post. R actually meet, cannot be decided due to displacement of plates.

Measurements: Maximum height: 42·5 mm.; maximum width: 53 mm.; minimum width: 34 mm. Dimensions of individual plates may be obtained from Text-figure 1*c*.

Locality: McCoy gives his specimen as derived from "the soft gray shale of Darlington, N.S. Wales".

Remarks: The holotype establishes beyond doubt that in *Tribrachiocrinus* the r. and l. ant. RR did not bear brachials. The flattened inner surfaces of the peculiar protuberances of the dorsal margins of these RR, together with that of the rt., probably supported plates of the tegmen.

Affinities: From the above description it can be seen that, in all aspects of its morphology, *Tribrachiocrinus* is manifestly inadunate. Concerning Strimple's (1951) suggestion that it is a flexible crinoid the following points should be noted:

1. Although the IB circlet is tripartite, this cannot be taken as indicating any affinity with the Flexibilia. In this group the small IB is that of the r. post., whereas in *Tribrachiocrinus* it is in the ant. Moreover, in the Upper Palaeozoic Flexibilia the IB circlet is greatly diminished in size, so that it is often concealed entirely by the stem.

2. The arrangement of large anal plates (RA, X, rt) within the cup is fully typical of many inadunate crinoid groups, but I know of no similar arrangements within the Flexibilia, even in the family Lecanocrinidae.

3. Although the distal articulating faces of the radials are neither well preserved nor wide, the deep transverse ligament pit is suggestive of inadunate rather than flexible crinoid affinities. Indeed, Wachsmuth and Springer (1886, p. 200) have observed that "the mode of articulation is similar to that of all late Poteriocrinidae".

Among dicyclic inadunate crinoids *Tribrachiocrinus* finds its closest relative in *Sundacrinus*, a fact originally pointed to by Wanner (1916, p. 220; 1923, p. 193). In common with *Tribrachiocrinus*, *Sundacrinus* lacks arms in the r. and l. ant. radii, although it differs in possessing five IBB. *Indocrinus* Wanner 1916, also from the Permian of Timor, has plating more similar to that of *Tribrachiocrinus*, although the form of the calyx is markedly different. Other genera which appear to be related to this group are *Parindocrinus* Wanner 1937, *Hemiindocrinus* Jakovlev 1926 and *Tetrabrachiocrinus* Jakovlev 1934. These forms may be conveniently placed together in the family Sundacrinidae Moore and Laudon 1943, which is therefore confined to the Permian of Australia, Timor and Russia. Among other features, the group is characterized by high IBB, and a marked inequality of the size of the RR which leads to atrophy of one or more rays. The Scottish Lower Carboniferous species *Hosiecrinus caledonicus* (Wright), originally referred to *Tribrachiocrinus*, lacks these two features which suggests that it represents an earlier independent development of atrophied rays in dicyclic inadunate crinoids. The suppression of rays is seen in other Inadunata, e.g., late members of the Codiacrinidae and the Erisocrinidae.

Concerning the general asymmetry of the Sundacrinidae, A. H. Clark (1914) has shown that outside an optimum temperature range (12·7–18·3° C.) living comulatids tend to become malformed during growth. Radials may be atrophied, and the number of arms increased or reduced. This has led Wanner (1949) to suggest that the great number of irregular types of crinoids present in the Permian of Timor may have been caused by sea temperatures above the optimum.

References.

Bather, F. A., 1890.—British fossil crinoids. II. The classification of the Inadunata Fistulata. *Ann. Mag. nat. Hist.*, 55: 373-88.

————, 1900.—The Crinoidea *in* E. R. Lankester, *A Treatise on Zoology*. III. *The Echinoderma*. Adam & Charles Black, London.

Clark, A. H., 1914.—The relation between recent crinoids and the temperature of their habitat. *Journ. Wash. Acad. Sci.*, 4 (20): 579-83.

Etheridge, R., 1892.—A monograph of the Carboniferous and Permo-Carboniferous invertebrata of New South Wales. Pt. II. Echinodermata, etc. *Pal. Mem. geol. Surv. N.S.W.*, 5: 65-119.

Koninck, L. de, 1887.—Recherches sur les fossiles Paléozoiques de la Nouvelle Galles du Sud (Australie). *Mém. Soc. Sci. Liège*, 6: 158-68.

McCoy, F., 1847.—On the fossil botany and zoology of the rocks associated with the coal of Australia. *Ann. Mag. nat. Hist.*, 20: 226-36.

Moore, R. C., and L. R. Laudon, 1943.—Evolution and classification of Paleozoic crinoids. *Spec. Pap. geol. Soc. Amer.*, 46.

STRIMPLE, H. L., 1951.—Pennsylvanian crinoids from Lake Bridgeport, Texas. *Journ. Paleont.*, 25: 200-7.

WACHSMUTH, C., and F. SPRINGER, 1886.—Revision of the Palaeocrinoidea. III (2). *Proc. Philadelph. Acad. nat. Sci. 1886*: 64-226.

WANNER, J., 1916.—Die permischen Krinoiden von Timor. I. *Paläont. Timor*, 6: 1-329.

————, 1923.—Die permischen Krinoiden von Timor. *Verhand. Jahrb. Mijn. nederl. Oost-Indië 1921*: 1-348.

————, 1949.—Ungleiche Primaxillaria und andere Abweichungen von der normalen Symmetrie bei paläozoischen Crinoiden. *N. Jahrb. Min. Geol. Paläont.*, B91: 81-100.

WRIGHT, J., 1936.—New Scottish Carboniferous crinoids. *Geol. Mag.*, 73: 385-412.

————, 1952.—The British Carboniferous Crinoidea. I (IV). *Palaeontogr. Soc. Monograph*, 103-48.

EXPLANATION OF PLATE III.

Tribrachiocrinus clarkei McCoy.

Figs 1, 2, 3, 4. Posterior, ventral, dorsal and anterior views of holotype. ×1·5. Fig. 5. Oblique dorsal view of calyx, showing radial facets. ×2.